11 Data Modeling and TSFMS Format Recommendations

TSFMS Objectives

Baker believes that the two most critical factors that the Tri-Service Center must consider in developing the TSFMS are the following:

1) How will facility managers access environmental information as technology progresses?

2) How can the database structures be standardized so that information can be transferred between military installations?

During Baker's site interviews, it was found that environmental managers are primarily using spreadsheets and/or self-contained (often proprietary) databases to manage their electronic information. While this generally provides for adequate electronic record keeping, it does not permit information sharing between people on base nor between environmental managers conducting similar activities at other installations. Most facility managers like the concept of accessing facility management information through a GIS system; however, they believe that a GIS should be a secondary means of data retrieval/presentation. There was a greater comfort level with accessing and inputting information through more traditional database applications. Therefore, the Tri-Service Center needs to provide the necessary links between the spatial components of the TSSDS and the non-graphical TSFMS facility management data tables. However, the non-graphic tables must still be accessible through other database accessing means/applications.

As technology progress and the DOD streamlines their operations, it will be necessary to maintain facilities management data through a centralized database system. Databases allow numerous advantages over the independent systems that many installations are currently implementing. First, sharing of information between facility managers and installations becomes possible. Also, standardized databases are capable of being accessed either through multiple desktop applications (such as the ENRMS module of the APMM) or through spatial GIS software. (Interfacing may be necessary for some applications.) In addition, statistical analyses and costing analyses can be implemented to help make better business decisions at lower cost. In this report, Baker makes recommendations for TSFMS formatting to accomplish this goal.

Non-Graphic Information (TSFMS)

Baker's review of the TSSDS structure revealed that numerous tables of a non-graphical nature already exist which are necessary for general facilities management information which can be linked to ***enviromental_compli-ance*** specific tables. Numerous tables under the ***common*** and ***environmental_hazards*** entity sets were found to be non-graphic and deemed to have greater applicability to a facilities management

through a database (typical non-graphic user interface) interface than through a GIS interface.

As shown on Table 1, Baker recommended that most of the non-graphic tables under these two entity sets be moved to the TSFMS, yet remain linked to the graphic components of the TSSDS as necessary. This will allow for greater ease of managing data that is not easily represented spatially, but which is required for the thorough management of all facilities.

Not all of the non-graphic tables should be migrated to the TSFMS. Similar tables should be constructed (e.g., cmgenmet) or should have a parallel table in the TSFMS. Other non-graphic tables which describe geospatial entities should remain within the TSSDS.

Graphic Information (TSSDS)

It is recommended that all information designated as being graphical in nature (entity identification number, name, coordinates, etc.) remain in the existing TSSDS spatially related tables. Some of the entities will require either representation via a new/modified symbol or to add discriminators to differentiate based on environmental compliance status or category. It is recommended that records in each graphic table be modified to contain the appropriate foreign keys to allow the data to be linked to the non-graphic TSFMS data. Although it is not envisioned that a GIS will be the primary access to that information by facility managers, the capability should be included as each manager has different needs and preferences.

Environmental Projects

Almost every environmental project incorporates compliance issues that must be addressed. Depending on the task-on-hand, the regulations with which the activity must comply may be enforced by different agencies at the federal, state or local level, or a combination thereof. Baker initially considered dividing the non-graphic TSFMS compliance information relating to the nine environmental topics (see Section 1) into the following four (4) entity sets, roughly corresponding with the type of agency responsible for enforcing the action:

1. environmental_compliance
2. osha_compliance
3. transportation_compliance
4. voluntary_compliance

However, as the TSSDS was established based primarily on project type, it was decided that only one new entity set, ***environmental_compliance***, be established with references to the appropriate type of compliance established only in the "Common Name" field associated with each table. This helps to minimize confusion on where to find the appropriate tables when browsing the TSFMS data structure through an application such as the TSSDS.

Air Emission/Air Quality

Proposed TSFMS Data Model Structure

The following non-graphical information groups (entity classes) related facilities management were identified:

Air Pollutant
Air Emissions Activity Profile
Air Emissions Permits
Air Emissions Permit Applications
Emissions Monitoring
Emissions Reporting - Quality
Emissions Control Maintenance
Training
Emissions Compliance Audits
Emissions Inspections

The proposed data structure for air emission/air quality compliance is presented in Appendix G, Tables G1 through G5. The preliminary data model for air emissions/air quality compliance is provided as Figure 1. The data

model is presented as a preliminary indication of how the TSFMS tables might link to the existing TSSDS tables (graphic and non-graphic).

A table has been developed for each of the ten categories listed. Baker has given each new table Tri-Service compliant nomenclature. In addition, attribute names have been made Tri-Service compliant. Sources for the attributes as identified through Baker's research and development effort are listed on Table G5.

Modifications to the TSSDS

The existing TSSDS contains no "non-graphic" tables specifically related to air emissions or air quality for incorporation into the TSFMS. Therefore, Baker recommends only adding the appropriate keys to the TSSDS tables to be able to access the non-graphical information of the TSFMS from a CADD/GIS application.

In addition, no additional entity types for incorporation into the TSSDS were revealed during Baker's research. However, based on a review of TSSDS v. 1.7, and on discussions with air quality personnel, the Tri-Service Center should modify the symbol for an air quality monitoring station. This modification should be based on whether it is an internal (on-site), facility boundary, or external (off-site) monitoring station. This can be done simply by assigning a discriminator to vary the color of symbol #101 (ECAQMS) or by addition of a subscript (e.g., A_i, A_{fb}, or A_e) to the graphic feature.

In addition, no symbol is currently present under the entity type ***air_emissions_source_site*** (a point/polygon object). Baker recommends that a standard symbol for a point source be adopted and assigned discriminators such that it can be modified (by color) to indicate whether or not the source is permitted.

Surface Water Discharges

Proposed TSFMS Data Model Structure

The following non-graphical information groups (entity classes) were identified as being necessary for the management of data related to surface waste discharges:

Surface Water Discharge Pollutant
Surface Water Discharge Activity Profile
Surface Water Discharge Permits
Surface Water Discharge Permit Applications
Discharge Monitoring
Reporting - Quality
Discharge Systems/Equipment Maintenance
Operator Training
Discharge Compliance Audits
Outfall Inspections

The proposed data structure for surface water compliance is presented in Appendix G, Tables G1 through G5. The preliminary data model for surface water discharge compliance is provided as Figure 2. The data model is presented as a preliminary indication of how the TSFMS tables might link to the existing TSSDS tables (graphic and non-graphic).

A separate attribute table has been developed for each of these entity classes.
Baker has given each new table Tri-Service compliant nomenclature. In addition, attribute names have been made Tri-Service compliant. Sources for the attributes as identified through Baker's research and development effort are listed on Table G5.

Modifications to the TSSDS

The existing TSSDS contains no “non-graphic” tables for incorporation into the TSFMS. Therefore, Baker recommends only adding the appropriate keys to the TSSDS tables

to allow access to the non-graphical information of the TSFMS from a CADD/GIS application.

One additional entity type was identified for incorporation into the surface water section of the TSSDS during Baker's research. It is recommended that a new entity type be introduced called ***surface_water_ disc_monitoring_station_point***. The entity itself exists, but appears to be misplaced under the ***groundwater_quality_monitoring_ station_point*** entity class. There also appears to be some confusion as similar entities exists under the ***utilites*** entity set: ***industrial_waste_discharge_point***, ***storm_sewer_discharge_point, wastewater_discharge_point***. Typically, storm sewers are considered part of utilities, while wastewater treatment facilities (industrial and sanitary) and their associated outfalls are considered part of an environmental treatment operations. The Tri-Service Center may want to consider shifting industrial waste and wastewater under the ***environmental_hazards*** entity set and providing additional clarification as to the definition of each entity.

Based on review of TSSDS v. 1.7 and discussions with wastewater/storm water professionals, the symbol for the ***surface_ water_disc_monitoring_station_point*** (symbol #114, ECSWMS) should indicate whether the source of the discharge is wastewater, storm water, or mixed. Baker recommends the addition of a subscript (e.g., SW_{ww}, SW_{st}, and SW_{mx}) to the graphic feature to make this indication. These symbols also need to be varied to indicate the station's compliance related location as an internal, an end-of pipe, or an edge of mixing zone outfall. This can be done simply by varying the color codes used for each entity through discriminators.

In addition, the field sample collection location point entity needs to include separate symbols for surface water (not directly related to discharges), wastewater, storm water, and mixed wastewater/storm water sample locations. Baker recommends the addition of a subscript (e.g., W_s, W_{ww}, W_{st}, and W_{mx}) to the graphic feature to make this indication.

Hazardous Materials

Proposed TSFMS Data Model Structure

The following non-graphical information groups (entity classes) were identified as being necessary for the management of data related to hazardous materials compliance/management:

Hazardous Materials Inventory
Hazardous Materials Storage
Hazardous Materials Safety Data
Hazardous Materials Training
Hazardous Materials Issuance

The proposed data structure regarding hazardous materials compliance is presented in Appendix G, Tables G1 through G5. The preliminary data model for hazardous materials compliance is provided as Figure 3. The data model is presented as a preliminary indication of how the TSFMS tables might link to the existing TSSDS tables (graphic and non-graphic).

A separate attribute table has been developed for each of these entity classes.
Baker has given each new table Tri-Service compliant nomenclature. In addition, attribute names have been made Tri-Service compliant. Sources for the attributes as identified through Baker's research and development effort are listed on Table G5.

Modifications to the TSSDS

The existing TSSDS contains several “non-graphic” tables associated with hazardous materials:

ehhwmcma
ehhwmcpp
ehhwmmem
ehhwmmiw
ehhwmrwa

Baker recommends moving these tables to the TSFMS. The appropriate keys to the TSSDS tables to allow access to the non-graphical information of the TSFMS from a CADD/GIS application, should already exist. New keys will need to be added to link the graphic and non-graphic TSSDS tables to the proposed new environmental compliance tables, as appropriate.

No additional entities were identified for incorporation into the TSSDS. The five existing entity types (tables) should be sufficient to represent hazardous materials adequately from a graphics standpoint:

ehhmwhml	(location - non-graphic parent table)
ehhmwhma	(storage area)
ehhmwhmb	(storage building)
ehhmwhmr	(storage room)
ehhmwhmv	(storage vault)

Hazardous Wastes

Proposed TSFMS Data Model Structure

The following non-graphical information groups (entity classes) were identified as being necessary for the management of data related to hazardous waste compliance/management:

Hazardous Waste Inventory
Hazardous Waste Activity Profile
Hazardous Waste Permits
Hazardous Waste Risk Assessment
Hazardous Action Plans
Hazardous Waste Training
Hazardous Waste Exposure - Worker
Hazardous Waste Exposure - Remediator
Hazardous Waste Storage
Hazardous Waste Transportation
Hazardous Waste Treatment/Disposal

The proposed data structure regarding hazardous materials compliance is presented in Appendix G, Tables G1 through G5. The preliminary data model for hazardous waste compliance is provided as Figure 4. The data model is presented as a preliminary indication of how the TSFMS tables might link to the existing TSSDS tables (graphic and non-graphic).

A separate attribute table has been developed for each of these entity classes.
Baker has given each new table Tri-Service compliant nomenclature. In addition, attribute names have been made Tri-Service compliant. Sources for the attributes as identified through Baker's research and development effort are listed on Table G5.

Modifications to the TSSDS

The existing TSSDS contains several “non-graphic” tables associated with hazardous wastes:

ehhwmcpw
ehhwmcwa
ehhwmmew
ehhwmmiw
ehhwmrwa

Baker recommends moving these tables to the TSFMS. The appropriate keys to the TSSDS tables, to allow access to the non-graphical information of the TSFMS from a CADD/GIS application, should already exist. New keys will need to be added to link the graphic and non-graphic TSSDS tables to the proposed new environmental compliance tables, as appropriate.

No additional entities were identified for incorporation into the TSSDS. The five existing entity types should be sufficient to represent hazardous waste adequately from a graphics standpoint:

ehhmwhsl	(location - non-graphic parent table)
ehhmwhsa	(storage area)
ehhmwhsb	(storage building)
ehhmwhsr	(storage room)
ehhmwhsv	(storage vault)

Regulated Storage Tanks

Proposed TSFMS Data Model Structure

The following non-graphical information groups (entity classes) were identified as being necessary for the management of data related to AST and UST compliance/management:

Tank Inventory
Tank Contents and Conditions
Tank Permits
Tank Spill Management
Tank Training
Tank Entries
Tank Inspections

The proposed data structure for regulated storage tanks compliance is presented in Appendix G, Tables G1 through G5. The preliminary data model for regulated storage tank compliance is provided as Figure 5. The data model is presented as a preliminary indication of how the TSFMS tables might link to the existing TSSDS tables (graphic and non-graphic).

A separate attribute table has been developed for each of these entity classes.
Baker has given each new table Tri-Service compliant nomenclature. In addition, attribute names have been made Tri-Service compliant. Sources for the attributes as identified through Baker's research and development effort are listed on Table G5.

Modifications to the TSSDS

The existing TSSDS contains one “non-graphic” table associated with tanks:

ehtnktnk

Baker recommends that this table be kept with the TSSDS because it is a parent table to other graphic AST (ehtnkast), UST (ehtnkust) and tank farm (ehtnkfrm) related tables. These four existing entity types should be sufficient to represent tank management. However, Baker recommends using discriminators to indicate whether an AST or UST is permitted (regulated), unpermitted, or abandoned. During the site interviews, facility managers indicated that nearly all tanks were managed, whether they are regulated or not.

PCBs Management

Proposed TSFMS Data Model Structure

The following non-graphical information groups (entity classes) were identified as being necessary for the management of data related to regulated storage tank compliance/management:

PCB Inventory
PCB Surveys
PCB Risk
PCB Action Plans
PCB Exposure - Worker
PCB Exposure - Remediator
PCB Storage
PCB Transportation
PCB Treatment/Disposal

The proposed data structure for PCBs compliance is presented in Appendix E, Tables G1 through G5. The preliminary data model for PCBs compliance is provided as Figure 6. The data model is presented as a preliminary indication of how the TSFMS tables might link to the existing TSSDS tables (graphic and non-graphic).

A separate attribute table has been developed for each of these entity classes.
Baker has given each new table Tri-Service compliant nomenclature. In addition, attribute names have been made Tri-Service compliant. Sources for the attributes as identified through Baker's research and development effort are listed on Table G5.

Modifications to the TSSDS

The existing TSSDS contains no “non-graphic” tables associated with PCBs. The single

existing entity types (ehhwmpcb) should be sufficient to represent PCBs management. However, Baker recommends using discriminators to indicate whether a contained PCB source remains to be or has been remediated. During the site interviews, facility managers indicated that most sources had already been remediated, but it was very important to maintain historical records of sources that have been remediated in the event of an audit. These should be available through a GIS interface.

ACM Management

Proposed TSFMS Data Model Structure

The following non-graphical information groups (entity classes) were identified as being necessary for the management of data related to ACM compliance/management:

ACM Inventory
ACM Surveys
ACM Risk
ACM Action Plans
ACM Exposure - Worker
ACM Exposure - Remediator
ACM Storage
ACM Transportation
ACM Treatment/Disposal

The proposed data structure for ACM compliance is presented in Appendix E, Tables G1 through G5. The preliminary data model for ACM compliance is provided as Figure 7. The data model is presented as a preliminary indication of how the TSFMS tables might link to the existing TSSDS tables (graphic and non-graphic).

A separate attribute table has been developed for each of these entity classes.
Baker has given each new table Tri-Service compliant nomenclature. In addition, attribute names have been made Tri-Service compliant. Sources for the attributes as identified through Baker's research and development effort are listed on Table G5.

Modifications to the TSSDS

The existing TSSDS contains one “non-graphic” tables associated with ACM (ehbdhacm). In addition, a common graphical table is used to define ACM, lead-paint, and indoor air hazards. Baker recommends moving the non-graphic table to the TSFMS. The appropriate keys to the TSSDS tables, to allow access to the non-graphical information of the TSFMS from a CADD/GIS application, already exist. New keys will need to be added to link the graphic TSSDS tables to the proposed new environmental compliance tables, as appropriate.

The single existing entity types (ehbdhbdh) should be sufficient to represent ACM. The symbology must remain generic, because ACM problems are three-dimensional (not two-dimensional), making it impossible to represent every individual source spatially. However, facility managers must manage and track the activities associated with each source, thus necessitating non-graphical ACM management tables. Baker recommends using discriminators to indicate whether a building hazard is attributed to ACM, lead-based, paint, or an indoor air quality problem.

Lead-Paint Management

Proposed TSFMS Data Model Structure

The following non-graphical information groups (entity classes) were identified as being necessary for the management of data related to lead-based paint compliance/management:

Lead-Paint Inventory
Lead-Paint Surveys
Lead-Paint Risk
Lead-Paint Action Plans
Lead-Paint Exposure - Worker

Lead-Paint Exposure - Remediator
Lead-Paint Storage
Lead-Paint Transportation
Lead-Paint Treatment/Disposal

The proposed data structure for lead-paint compliance is presented in Appendix E, Tables G1 through G5. The preliminary data model for hazardous waste compliance is provided as Figure 8. The data model is presented as a preliminary indication of how the TSFMS tables might link to the existing TSSDS tables (graphic and non-graphic).

A separate attribute table has been developed for each of these entity classes.
Baker has given each new table Tri-Service compliant nomenclature. In addition, attribute names have been made Tri-Service compliant. Sources for the attributes as identified through Baker's research and development effort are listed on Table G5.

Modifications to the TSSDS

The existing TSSDS contains one "non-graphic" table associated with
lead-based paint (ehbdhlph). In addition, a common graphical table is used to define ACM, lead-paint, and indoor air hazards. Baker recommends moving the non-graphic table to the TSFMS; the appropriate keys to the TSSDS tables to allow access to the non-graphical information of the TSFMS from a CADD/GIS application already exist. New keys will need to be added to link the graphic TSSDS tables to the proposed new environmental compliance tables, as appropriate.

The single existing entity types (ehbdhbdh) should be sufficient to represent lead-paint. The symbology must remain generic, because lead-paint problems are three-dimensional (not two-dimensional), making it impossible to represent every individual source spatially. However, facility managers must manage and track the activities associated with each source, thus necessitating non-graphical lead-paint management tables. Baker recommends using discriminators to indicate whether a building hazard is attributed to ACM, lead-based, paint, or an indoor air quality problem.

Indoor Air Quality Management

Proposed TSFMS Data Model Structure

The following non-graphical information groups (entity classes) were identified as being necessary for the management of data related to indoor air hazards compliance/management:

Indoor Air Complaints Log
Indoor Air Standards (Voluntary)
Indoor Air Monitoring
Indoor Air Corrective Actions

The proposed data structure for indoor air quality management is presented in Appendix G, Tables G1 through G5. The preliminary data model for hazardous waste compliance is provided as Figure 8. The data model is presented as a preliminary indication of how the TSFMS tables might link to the existing TSSDS tables (graphic and non-graphic). Indoor air quality is unique in that it is the only topic where compliance is completely voluntary. Although standards exist for various industries, they are not enforceable by any government agency.

A separate attribute table has been developed for each of these entity classes.
Baker has given each new table Tri-Service compliant nomenclature. In addition, attribute names have been made Tri-Service compliant. Sources for the attributes as identified through Baker's research and development effort are listed on Table G5.

Modifications to the TSSDS

The existing TSSDS contains one “non-graphic” table associated with Indoor air hazards (ehbdhiah). In addition, a common graphical table is used to define ACM, lead-paint, and indoor air hazards. Baker recommends moving the non-graphic table to the TSFMS. The appropriate keys to the TSSDS tables, to allow access to the non-graphical information of the TSFMS from a CADD/GIS application, already exist. New keys will need to be added to link the graphic TSSDS tables to the proposed new environmental compliance tables, as appropriate.

The single existing entity types (ehbdhbdh) should be sufficient to represent indoor air hazards. Baker recommends using discriminators to indicate whether a building hazard is attributed to ACM, lead-based, paint, or an indoor air quality problem. The symbology must remain generic because indoor air quality problems may be from a combination of sources or unknown sources, or may be widespread, making it difficult to represent two-dimensionally.

Model Consolidation for Final Report

For each of the topics discussed above, Baker has created a new table for each category and each task. For the final document, we expect to be able to consolidate some of these tables under a ***common_general*** entity class within the TSFMS. For example, there is no reason why training issues cannot be consolidated into a single table accessible and queryable through a single table (rather than one for hazardous materials, one for hazardous waste, one for tanks, etc.). Other entity types may also be consolidated, such as:

Action Plans (Baker may just enhance the existing cmgenpln)
Risks
Exposure - Worker and Remediator

Other items such as inventories and waste tracking from cradle-to-grave (storage, transportation, treatment/disposal) should remain independent based on waste type. Additional work needs to be done to pare down the overall data structure, normalizing the data, and developing data relationships between the graphic and non-graphic tables. These items will require an extensive effort, but are highly recommended to enable the database to be more functional. Such an effort would likely result in modifications, additions, and deletions to the proposed data structures presented herein.

Browser Recommendations

Baker has reviewed the new Browser features available in the TSSDS v. 1.75 and finds the new capabilities and ease of standards browsing to be a great enhancement to the application. It is Baker's belief that the TSSDS and TSFMS could be (and need to be as join relations must eventually be established) relatively easily merged into a common application. The TSSDS already contains a lot of common tables that are TSFMS oriented. Baker recommends having the capability to browse the non-graphical TSFMS tables separately from the graphical TSSDS tables (primarily). Establishing a separate set of buttons for the TSFMS which recognize only database records tables which include "TSFMS" (or "FMS" in v. 1.7) in the "STANDARDS" field would allow selective browsing. Likewise, programming to get the existing TSSDS buttons to recognize "TSSDS" (or "SDS" in v. 1.7) in the "STANDARDS" field would allow only the graphic tables to be viewed. With minor modifications, the TSSDS package could be expanded to include both the TSSDS and the TSFMS in a single browser package.